Micro-scale modelling of energy fluxes over a small Fluxnet forest site in Denmark - DTU Orbit (08/11/2017)

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Most forests, especially in Europe, are too small to fulfil strict fetch requirements associated with idealized flux observations in undisturbed, homogeneous flow. As a consequence of limited fetch, the flux measured above the canopy will often deviate from the source strength underlying the measurements. Since representative measurements focused on heterogeneous effects are scarce because of demanding experimental arrangements the numerical modelling are often recruited for analysis of these deviations. During the last years the atmospheric boundary layer (ABL) model SCADIS (scalar distribution model; Sogachev et al., 2002, Tellus 54B, 784-819) has been successfully applied especially in the region adjacent to a forest edge in order to improve flux data interpretation. Most of the analyses were done for the neutral case and in two-dimensional mode. When analyzing the effect of a forest edge on both flow and passive scalar properties, numerical studies showed that sources located on a soil surface are major contributors to wave-like flux behavior downwind of the leading edge, and that it is important to distinguish the effects of ground sources from those of the foliage. In the present work, we apply the SCADIS model with enhanced turbulence closure including buoyancy for investigation of the daily course of energy fluxes over patchy forested terrain in Denmark, where the model is used in three-dimensional mode. The modelling results (with 50 m horizontal resolution) are in good qualitative agreement with high-resolution (60 m and 120 m) remote-sensing data of the effective surface temperature of the area near the site in focus: the forested areas are colder in daytime and warmer in night time than surrounding open areas. In contrast to the remote sensing approach, SCADIS provides the information about spatial distribution of latent and sensible heat vertical fluxes in the whole ABL. Topography and forest edge effects result in vertical turbulent fluxes that deviate significantly from the original sources producing apparent local energy imbalance, when advection is not considered. A closer look at the result shows that though the measuring mast is located in the middle of a forest patch by size about 1x2 km2, it is not free from uncertainties regarding energy balance closure and that caution is needed when interpreting measured flux data. The approach used in this work can be utilized in interpretation of already existed experimental data and in the planning of future experiments.

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